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NATIONAL DAM SAFETY PROGRAM, LAKE DEVOLIA DAM. (INVENTORY NUMBER--ETC(U)
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Name of Dam: Lake Devolia Dam

Location: Caroline County, Commonwealth of Virginia

Inventory Number: VA 03331

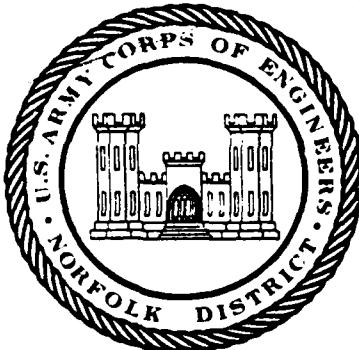
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PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

Lake Devolia Dam (Inventory Number VA-03331), York River Basin,
Caroline County, Commonwealth of Virginia, Phase I Inspection Report.



(10) James A. Walsh

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20. Abstract

Pursuant to Public Law 92-367, Phase I Inspection Reports are prepared under guidance contained in the recommended guidelines for safety inspection of dams, published by the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I Inspection is to indentify expeditiously those dams which may pose hazards to human life or property. The assessment of the general conditions of the dam is based upon available data and visual inspection. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

Based upon the field conditions at the time of the field inspection and all available engineering data, the Phase I report addresses the hydraulic, hydrologic, geologic, geotechnic, and structural aspects of the dam. The engineering techniques employed give a reasonably accurate assessment of the conditions of the dam. It should be realized that certain engineering aspects cannot be fully analyzed during a Phase I inspection. Assessment and remedial measures in the report include the requirements of additional indepth study when necessary.

Phase I reports include project information of the dam appurtenances, all existing engineering data, operational procedures, hydraulic/hydrologic data of the watershed, dam stability, visual inspection report and an assessment including required remedial measures.

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of the Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (flood discharges that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the design flood should not be interpreted as necessarily posing a highly inadequate condition. The design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition, and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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NAME OF DAM: LAKE DEVOLIA DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Lake Devolia Dam
State: Commonwealth of Virginia
County: Caroline
USGS 7.5 Minute Quadrangles: Ladysmith, VA and Hewlett, VA
Stream: Unnamed Tributary to South River
Date of Inspection: 28 October 1980

BRIEF ASSESSMENT OF DAM

Lake Devolia Dam is an earthfill embankment approximately 20.6 feet high¹ and 460 feet long. The principal spillways consist of one 24-inch and one 36-inch diameter corrugated metal pipes (C.M.P.) which pass through the embankment at the right² abutment and approximate center of the dam, respectively. The left and right emergency spillway areas are natural overflow areas and are adjacent to the left and right abutments of the dam. The dam is located in Caroline County, approximately 1.8 miles west of Ladysmith, Virginia. The dam is owned by the Lake Land'or Property Owner's Association and is used for recreation. Lake Devolia Dam is a "small" size - "significant" hazard structure as defined by the Recommended Guidelines for Safety Inspection of Dams. The dam and appurtenant structures were in poor condition at the time of the inspection.

Using the Corps of Engineers' screening criteria for the initial review of spillway adequacy, the 1/2 Probable Maximum Flood (1/2 PMF) was selected as the spillway design flood (SDF) for Lake Devolia Dam. The SDF was routed through the reservoir and found to overtop the dam by a maximum depth of 1.0 feet with an average critical velocity of 4.6 feet per second (f.p.s.). Total duration of dam overtopping would be about 1.2 hours. The spillways are only capable of passing up to 23 percent of the Probable Maximum Flood without overtopping the dam. However, overtopping could be detrimental to the dam considering the present eroded and sparsely vegetated condition of the downstream embankment. Therefore, the spillways are adjudged as inadequate. The spillways were not adjudged as seriously inadequate since there is not a high hazard to loss of life from large flows downstream of the dam.

¹Measured from the streambed at the downstream toe of the dam to the embankment crest.

²Facing downstream.

NAME OF DAM: LAKE DEVOLIA DAM

Visual inspection and office analyses indicate deficiencies requiring remedial treatment.

The seep area should be examined at regular intervals and after periods of heavy rains for any signs of increased flow or turbidity, which may indicate the potential for piping of embankment material. If increased flow from the seep area or turbidity are noted, a qualified geotechnical engineering firm should be retained to perform a stability check of the dam.

A warning system and emergency action plan should be developed and put into operation as soon as possible. The emergency action plan should list steps to be taken to help prevent failure of the dam in an emergency.

The following measures should be undertaken as part of a regularly scheduled inspection and maintenance program:

- 1) The left half of the downstream slope should be filled to a minimum slope of 2.5H:1V, compacted, graded, and seeded. A rock fill toe drain with proper filter should be constructed initially.
- 2) Fill, regrade, and recompact all areas of erosion on the embankment and establish a good grass cover over the entire dam.
- 3) Riprap should be installed upstream and downstream of the roadway that passes through the natural left and right emergency spillway areas to prevent erosion to the left and right abutments of the dam.
- 4) Place riprap on the upstream embankment to minimize erosion due to wave action.
- 5) Clear the debris from the 24-inch principal spillway inlet, discharge area, and downstream channel.
- 6) Repair and riprap the eroded outlet area for the 24-inch principal spillway. Also, riprap around the outlet of the 36-inch spillway.
- 7) Fill in, compact and reseed the existing discharge channel for the 24-inch principal spillway and construct a new riprapped discharge channel away from the toe of the downstream embankment.
- 8) Install trash racks or screens at the inlets to the 24-inch and 36-inch principal spillways to prevent obstruction of flow.

NAME OF DAM: LAKE DEVOLIA DAM

- 9) Anchor the half-sections of 54-inch C.M.P. to the embankment to prevent slippage.
- 10) Extend half-sections of pipe in the discharge channel for the 36-inch principal spillway beyond the toe of the embankment and tie it in with the new 24-inch principal spillway discharge channel.
- 11) Install a staff gage to monitor reservoir levels above normal pool.
- 12) The pine trees seeded onto the embankment should be removed and the embankment mowed regularly.

MICHAEL BAKER, JR., INC. SUBMITTED:

Original signed by
JAMES A. WALSH

James A. Walsh, P.E.
Chief, Design Branch

Original signed by
JACK G. STARR

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Original signed by:
Douglas L. Haller

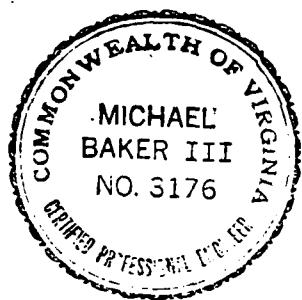
Douglas L. Haller
Colonel, Corps of Engineers
District Engineer

RECOMMENDED:

APPROVED:

Date:

JAN 30 1981



NAME OF DAM: LAKE DEVOLIA DAM



OVERALL VIEW OF DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NAME OF DAM: LAKE DEVOLIA DAM ID# VA 03331

SECTION 1 - PROJECT INFORMATION

1.1 General

1.1.1 Authority: Public Law 92-367, 8 August 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of safety inspections of dams throughout the United States. The Norfolk District has been assigned the responsibility of supervising the inspection of dams in the Commonwealth of Virginia.

1.1.2 Purpose of Inspection: The purpose is to conduct a Phase I inspection according to the Recommended Guidelines for Safety Inspection of Dams (Reference 12, Appendix IV). The main responsibility is to expeditiously identify those dams which may be a potential hazard to human life or property.

1.2 Description of Project

1.2.1 Description of Dam and Appurtenances: Lake Devolia Dam is an earthfill embankment approximately 20.6 feet high¹ and 460 feet long. The upstream and downstream embankment slopes vary. The upstream embankment ranges from approximately 2.0H:1V to 2.5H:1V (Horizontal to Vertical, respectively). The downstream embankment ranges from approximately 2.2H:1V to 2.6H:1V. The crest of the dam varies in width from about 28.0 feet wide to 32.3 feet wide. There is no information available on any possible zoning of the embankment. There is no slope protection on the embankment. A two-lane tar and chip roadway runs along the crest of the dam. The minimum top of dam at both abutments is at elevation 249.1 feet

¹Measured from the streambed at the downstream toe of the dam to the embankment crest.

NAME OF DAM: LAKE DEVOLIA DAM

Temporary Bench Mark (T.B.M.)² The elevation of the crest of the dam varies by about 1.5 feet to a maximum elevation of 250.6 feet T.B.M. near the center of the embankment. No evidence of an internal drainage system or slope protection for the dam was found.

The dam has two principal spillways. The first principal spillway is a 24-inch diameter corrugated metal pipe (C.M.P.) through the embankment. The 24-inch principal spillway is 40 feet long and located at the right abutment.³ The invert of the inlet of the 24-inch principal spillway is at elevation 245.0 feet T.B.M. and the slope of the pipe is approximately 1.0 percent (Photo 1). The discharge from the 24-inch principal spillway drops into an inadequately riprapped discharge area (Photo 2) and then follows a natural channel, along the junction of the downstream embankment with the right abutment (Photo 7), to an unnamed tributary and thence into South River about 1.1 miles downstream of the dam.

The second principal spillway is a 36-inch diameter C.M.P. through the embankment. The 36-inch principal spillway is 46.5 feet long and is located near the center of the embankment approximately 200 feet from the right abutment. The invert of the inlet of the 36-inch principal spillway is at elevation 245.4 feet T.B.M. and the slope of the pipe is approximately 4.1 percent (Photo 3). The discharge channel for the 36-inch principal spillway consists of unanchored half-sections of 54-inch diameter C.M.P. (Photo 4). The discharge from the 36-inch principal spillway flows through the half-section discharge channel for approximately 20 feet before dropping into a riprapped discharge area at and above the toe of the downstream embankment. The discharge then flows to the discharge channel of the 24-inch principal spillway just downstream of the dam.

²All elevations are referenced to a Temporary Bench Mark located on the top center of the principal spillway, 24 inch C.M.P., at the inlet. The assumed elevation is 247.0 feet.

³Facing downstream.

NAME OF DAM: LAKE DEVOLIA DAM

The emergency spillway system consists of two natural overflow areas adjacent to both abutments of the dam. The left emergency spillway area has a minimum elevation of 247.0 feet T.B.M. and an average width of approximately 75 feet. The right emergency spillway area has a minimum elevation of 249.1 feet T.B.M. and an average width of 100 feet (see Plate 2).

The reservoir is fed by runoff from a small (0.18 square miles) drainage area to the west of the dam. Nearly the entire drainage area falls within the Lake Land'or residential community project. The western section of the watershed is primarily farmland, while the eastern section is open woodland with scattered residences. Present development is limited to just a few houses, however, the area has been sub-divided into lots, creating the potential for considerable change in the watershed characteristics.

There are no facilities for draining the reservoir.

1.2.2 Location: Lake Devolia Dam is located in Caroline County, Virginia about 1.8 miles west of Ladysmith, Virginia and about 0.3 miles north of VA Route 639. The dam is situated just offstream from an unnamed tributary to South River. The dam is in the Lake Land'or residential community project. A Location Plan is included with this report in Appendix I.

1.2.3 Size Classification: The height of Lake Devolia Dam is 20.6 feet; the reservoir storage capacity at the average maximum top of the dam (elevation 250.4 feet T.B.M.) is 84 acre-feet. Therefore, the dam is in the "small" size category as defined by the Recommended Guidelines for Safety Inspection of Dams.

1.2.4 Hazard Classifications: A two-lane, tar and chip roadway runs along the crest of the dam. This road provides access to a portion of the Lake Land'or development. There are two highway bridges, VA Route 622 and U.S. Route 1, located 0.57 and 2.35 miles downstream of the

NAME OF DAM: LAKE DEVOLIA DAM

dam, respectively. At the U.S. Route 1 bridge over South River, a housing development and trailer park are located on the left. The majority of these structures are approximately 30 feet above the stream, but several are only 10 feet above the stream. Loss of human life in the event of a dam failure is not considered highly probable. However, economic losses due to damage to the roadway, the residences at U.S. Route 1, and the VA Route 622 highway bridge are likely in the event of a dam failure. Lake Devolia Dam is therefore considered in the "significant" hazard category as defined by the Recommended Guidelines for Safety Inspection of Dams. The hazard classification used to categorize dams is a function of location only and is not related to stability or probability of failure.

1.2.5 Ownership: The dam is owned by the Lake Land or Property Owner's Association, Box 123, Ladysmith, Virginia 22501.

1.2.6 Purpose: Lake Devolia Dam was constructed for recreational purposes.

1.2.7 Design and Construction History: Lake Devolia Dam was constructed in 1973 by J. R. Houston. No other information on design or construction history was available for use in this report.

1.2.8 Normal Operating Procedures: The reservoir level is maintained automatically by the crest of the 24-inch principal spillway (elevation 245.0 feet T.B.M.). No formal operating procedures are followed for this structure.

1.3 Pertinent Data

1.3.1 Drainage Area: The drainage area tributary to Lake Devolia Dam is 0.18 square miles.

1.3.2 Discharge at Dam Site: The maximum discharge from the reservoir is unknown.

Pool level at minimum top of dam:

24-inch Principal Spillway . . .	22 c.f.s.
36-inch Principal Spillway . . .	41 c.f.s
Emergency Spillway	280 c.f.s.

NAME OF DAM: LAKE DEVOLIA DAM

1.3.3

Dam and Reservoir Data: Pertinent data on the dam and reservoir are provided in the following table:

TABLE 1.1 DAM AND RESERVOIR DATA

Item	Elevation (feet T.B.M.)	Area (acres)	Reservoir Capacity			Length (feet)
			Acre- feet	Watershed (inches)		
Top of dam (average maximum)	250.4	13.7	84	8.8		1400
Left emergency spillway area (minimum)	247.0	9.6	45	4.7		1170
24-inch principal spillway invert	245.0	7.4	28	2.9		1000
Streambed at toe	229.8	-	-	-		-

NAME OF DAM: LAKE DEVOLIA DAM

SECTION 2 - ENGINEERING DATA

- 2.1 Design: Design plans, specifications, and boring logs were not available for use in preparing this report. No stability analyses or hydrologic and hydraulic data were available for review.
- 2.2 Construction: Construction records, as-built plans, and inspection logs were not available for review.
- 2.3 Evaluation: No design or construction records were available for use in assessing the condition of the dam. All evaluations and assessments in this report were based upon field observations, conversations with representatives of the owner, and office analyses.

NAME OF DAM: LAKE DEVOLIA DAM

SECTION 3 - VISUAL INSPECTION

3.1 Findings

3.1.1 General: The field inspection was conducted on 28 October 1980. At the time of the inspection, the pool elevation was at 244.5 feet T.B.M.; there was no ponded tailwater; and the weather was overcast with intermittent rain and temperatures between 45 and 50 degrees Fahrenheit. The ground surface at the embankment and abutments was damp. The dam and appurtenant structures were found to be in poor to fair overall condition at the time of the inspection. Deficiencies found during the inspection will require further investigation and remedial treatment. The following are brief summaries of deficiencies found during the inspection. A field sketch of conditions found during the inspection is presented as Plate 1 in Appendix I. The complete visual inspection checklist is provided in Appendix III. No record of any previous inspections was found.

3.1.2 Dam: The embankment was found to be in generally poor overall condition. The upstream embankment has been moderately eroded from precipitation, runoff, and wave action. There was no riprap observed on the upstream embankment and the vegetative cover was poor (Photo 8). The downstream embankment is moderately to severely eroded. The lower left section of the embankment is the most severely eroded (Photo 6). The toe of the downstream embankment has been badly eroded, particularly the right side where the 24-inch principal spillway discharge channel runs along the toe (Photo 7). A 50 foot long seepage area was observed along the left downstream toe of the embankment. Pine trees up to six feet in height have seeded onto the downstream embankment.

The abutments show little erosion with the exception of the junction of the downstream embankment and the right abutment. This area has been badly eroded by discharges from the 24-inch principal spillway (Photos 2 and 7).

NAME OF DAM: LAKE DEVOLIA DAM

No evidence of an internal drainage system was found during the inspection.

3.1.3 Appurtenant Structures: The appurtenant structures appear to be in fair overall condition.

The 24-inch principal spillway was not protected with a screen or trash rack. Trash (logs, etc.) was present in and near the inlet and debris (logs) was present in the outlet. The inlet area of the 24-inch principal spillway was not protected by riprap. The outlet area was riprapped, however, most of the riprap has been washed away and the 24-inch principal spillway outlet pipe has been undercut by about 2 feet due to erosion. The discharge channel for the 24-inch principal spillway has been severely eroded, forming a ditch up to four feet deep.

The 36-inch principal spillway was protected by a section of steel screen (3/4-inch mesh) held loosely against the lower half of the inlet with a steel stake (Photo 3). The screen was not clogged. The inlet area was not protected by riprap. The outlet area of the 36-inch principal spillway is protected by half-sections of 54-inch C.M.P. These half-sections do not extend all the way down the embankment (Photo 4). Discharges empty from the half-sections onto riprap just above the toe of the dam. The half-sections of 54-inch C.M.P. are not anchored. Some erosion, due to drainage from the crest, was observed around the top of the outlet pipe of the 36-inch principal spillway.

The left and right emergency spillway areas are natural overflow areas adjacent to the left and right abutments of the dam (Plates 1 and 2). There is no riprap on either side of the two lane tar and chip road that passes through the spillway areas and onto the crest of the dam.

No facilities for draining the reservoir were observed during the inspection.

3.1.4 Reservoir Area: The slopes around the reservoir are very gentle. The area immediately

NAME OF DAM: LAKE DEVOLIA DAM

surrounding Lake Devolia is the site of a large scale residential development called Lake Land'or. A few residences had been constructed at the time of the inspection, but the area was still primarily woodlands with some open, grassy spots. The banks of the reservoir were well vegetated with medium to tall grasses and some trees. No significant erosion of the reservoir banks was observed. The extent of sedimentation was not directly observed, but it is not expected to be significant. Soundings at the time of inspection indicated the depth of the reservoir to be about 11 feet approximately 100 feet offshore from the embankment.

3.1.5 Downstream Channel: The downstream channel beyond the immediate discharge area is a well defined, natural channel and is free of any significant debris or other obstructions. The slope of the downstream channel is less than one percent.

3.1.6 Instrumentation: There was no instrumentation at the dam site at the time of the inspection.

3.2 Evaluation: In general, the dam and appurtenant structures were found to be in poor overall condition. All areas of erosion on the embankment should be filled, regraded, recompacted, and a good grass cover should be established over the entire dam. The pine trees should be removed and the embankment mowed regularly. Riprap should be placed on the upstream embankment to minimize erosion from wave action.

The discharge area and channel for the 24-inch principal spillway should be cleared of debris. The eroded discharge outlet should be filled and the riprap replaced. The existing eroded discharge channel should be filled, compacted, and seeded. A new riprapped channel should be built away from the toe of the downstream embankment to carry the discharge from the 24-inch principal spillway away from the dam. The inlet for the 24-inch principal spillway should be cleared of debris and a trash rack or screen installed to prevent obstruction of flow.

The partial screen at the inlet to the 36-inch principal spillway should be replaced with a full trash rack or screen to prevent obstruction of flow. The eroded area

NAME OF DAM: LAKE DEVOLIA DAM

around the top of the outlet for the 36-inch principal spillway should be riprapped. The discharge channel consisting of half-sections of 54-inch C.M.P. should be anchored and extended beyond the toe of the embankment. Riprap should be placed around the end of the discharge channel to protect the toe from erosion.

Riprap should be installed upstream and downstream of the roadway that passes through the natural left and right emergency spillway areas to prevent erosion to the left and right abutments of the dam.

The seep area should be examined at regular intervals and after periods of heavy rains for turbidity and/or an increase in flow, which may indicate the potential for piping of embankment material. If turbidity or increased flows are noted, a qualified geotechnical engineering firm should be retained to perform a stability check of the dam.

A staff gage should be installed to monitor reservoir levels above normal pool.

NAME OF DAM: LAKE DEVOLIA DAM

SECTION 4 - OPERATIONAL PROCEDURES

- 4.1 Procedures: Operation of the dam is an automatic function controlled by the principal spillways and the left and right emergency spillway areas. Water entering the reservoir flows into the 24-inch principal spillway at elevation 245.0 feet T.B.M. When the inflow is sufficient, the reservoir level rises above elevation 245.4 feet T.B.M. and discharges through the 36-inch principal spillway. When the reservoir level rises above elevations 247 and 249.1, water will discharge through the left and right emergency spillway areas, respectively.
- 4.2 Maintenance of Dam: Maintenance of the dam is the responsibility of the owner. An inspection or maintenance schedule has not been instituted.
- 4.3 Maintenance of Operating Facilities: There are no operating facilities at the dam.
- 4.4 Warning System: At the present time, there is no warning system or emergency action plan in operation.
- 4.5 Evaluation: Past maintenance of the dam has been inadequate. Regular inspections should be made of the dam and appurtenant structures. A thorough check list should be compiled for use by the owner's representative as a guide for the inspections. Maintenance items should be corrected annually. A warning system and emergency action plan should be developed and put into operation as soon as possible.

NAME OF DAM: LAKE DEVOLIA DAM

SECTION 5 - HYDRAULIC/HYDROLOGIC DATA

5.1 Design: No design data were available for use in preparing this report.

5.2 Hydrologic Information: No rainfall, stream gage or reservoir stage records are maintained for this dam.

5.3 Flood Experience: No records were available.

5.4 Flood Potential: The Probable Maximum Flood (PMF), 1/2 Probable Maximum Flood (1/2 PMF), and 100-year flood were developed and routed through the reservoir by use of the HEC-1 DB computer program (Reference 9, Appendix IV) and appropriate unit hydrograph, precipitation and storage-outflow data. Clark's T_c and R coefficients for the local drainage areas were estimated from basin characteristics. The rainfall applied to the unit hydrograph was taken from publications by the U.S. Weather Bureau and the National Oceanic and Atmospheric Administration (References 16 and 17, Appendix IV). Rainfall losses for the PMF and 1/2 PMF were estimated at an initial loss of 1.0 inches and a constant loss rate of 0.05 inches per hour thereafter. Rainfall losses for the 100-year flood were estimated at an initial loss of 1.5 inches and a constant loss rate of 0.15 inches per hour thereafter.

5.5 Reservoir Regulation: Pertinent dam and reservoir data are provided in Table 1.1, Paragraph 1.3.3.

Regulation of flow from the reservoir is automatic. Normal flows are maintained by the crest of the 24-inch principal spillway at elevation 245.0 feet T.B.M. Water also flows through the 36-inch principal spillway in the event water in the reservoir rises above an elevation of 245.4 feet T.B.M. When the reservoir level rises above elevations 247.0 and 249.1, water will discharge through the left and right emergency spillway areas, respectively.

Outlet discharge capacity was computed by hand; reservoir area was estimated from the Ladysmith, Virginia, 7.5 minute USGS quadrangle; and storage capacity was computed by the HEC-1 DB program. All flood routings were begun with the reservoir at normal pool. Flow through the principal spillways was included in the routings.

5.6 Overtopping Potential: The probable rise of the reservoir and other pertinent information on reservoir performance are shown in the following table:

NAME OF DAM: LAKE DEVOLIA DAM

TABLE 5.1 RESERVOIR PERFORMANCE

Item	Hydrographs			
	Normal ¹	100-year flood	1/2 PMF	PMF ²
Peak flow, c.f.s.				
Inflow	0.5	569	1478	2955
Outflow	0.5	125	1197	2783
Peak elev., ft. T.B.M.	-	248.3	250.1	250.8
Left emergency spill-way area ³ (elev. 247.0 ft. T.B.M.)				
Depth of flow, ft.	-	1.3	3.1	3.7
Average velocity, f.p.s.	-	5.3	8.2	8.9
Duration of flow, hrs.	-	4.3	10.7	20.2
Non-overflow section ³ (elev. 249.1 ft. T.B.M.)				
Depth of flow, ft.	-	-	1.0	1.6
Average velocity, f.p.s.	-	-	4.6	5.9
Total duration of over-topping, hrs.	-	-	1.2	3.2
Tailwater elev., ft. T.B.M.	230.0	-	-	-

¹Approximate, no flow at time of inspection.

²The PMF is an estimate of flood discharges that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in a region.

³Velocity estimates were based on critical depth at control section.

5.7 Reservoir Emptying Potential: There are no facilities for draining the reservoir.

5.8 Evaluation: Lake Devolia Dam is a "small" size - "significant" hazard dam requiring evaluation for a spillway design flood (SDF) in the range between the 100-year flood and the 1/2 PMF. Due to the risk involved, the 1/2 PMF has been selected as the SDF. The 1/2 PMF was routed through the reservoir and found to reach a maximum water surface elevation 1.0 feet above the minimum top of dam elevation (elevation 249.1 feet T.B.M.). The spillways are capable of passing up to 23 percent of the PMF without overtopping the dam.

Conclusions pertain to present conditions and the effect of future development on the hydrology has not been considered.

NAME OF DAM: LAKE DEVOLIA DAM

SECTION 6 - DAM STABILITY

6.1 Foundation and Abutments: No previous information describing local subsurface conditions was available for the visual inspection or subsurface analyses. The dam is located along the border separating the Piedmont and the Coastal Plain physiographic provinces. The topography of the Piedmont (probably the most applicable) generally consists of rolling hills and gentle slopes with relief less than 150 feet. Granite gneiss of uncertain age is shown on the State geologic map as underlying the dam. Bedrock outcrops were not observed in the area of the dam during the field inspection. It is not known how the dam was keyed into the foundation and abutments. Relatively thick, primarily residual soils are expected to be present beneath the dam. The Piedmont physiographic province is reported to contain widespread, thick (50-150 feet) residual soils.

6.2 Embankment

6.2.1 Materials: Documented information describing the nature of the embankment materials or any zoning within the dam was not available for this inspection. During the field inspection, the outer embankment materials were determined to be comprised of red to brown sandy silt containing a little fine to medium gravel (ML group soil - Unified Classification System). These materials were almost certainly obtained locally. The area immediately downstream of the dam (north side) appears to have been a borrow area.

6.2.2 Stability: Design plans and the results of any previous stability analyses were not available for use during this evaluation. Therefore, the embankment is assumed to be a homogeneous type. The dam is 20.6 feet high with a minimum crest width of 28 feet. The upstream slope was determined to be 2.04-2.45H:1V. The downstream slope varied between 2.24-2.56H:1V. No facilities are available for draining the reservoir.

According to guidelines outlined in Design of Small Dams by the U.S. Department of the Interior, Bureau of Reclamation, the upstream slope of a small homogeneous dam constructed of slightly plastic fine grained soils (CL,

NAME OF DAM: LAKE DEVOLIA DAM

ML), with a stable foundation, should be 3H:1V if the dam is not subject to rapid drawdown. The downstream slope recommended is 2.5H:1V. A crest width of 14.1 feet is recommended, considering the height of the dam. Based on these guidelines, the upstream slope is inadequate, the downstream slope is locally too steep, while the crest width is more than adequate.

Signs of instability in the dam such as slumping, tension cracks, or unusual alignment along the crest were not observed during the visual inspection. However, the downstream embankment (particularly the lower one half) is moderately to severely eroded while the upstream embankment is moderately eroded. In addition, a deep (up to 4 feet) channel has been eroded by discharges from the 24-inch principal spillway along the junction of the right abutment with the downstream embankment. A long seepage area (50 feet) occurs along the left toe of the dam. The seepage appears to be occurring from in-place foundation soils (mottled light gray to brown slightly silty sand) which are exposed along the toe due to erosion. Flow from the seepage area was almost imperceptible. Even though an internal drainage system for the dam was not provided, the lower section of the downstream embankment was relatively dry.

6.2.3

Seismic Stability: The dam is located in Seismic Zone 2 which presents no hazard from earthquakes according to the Recommended Guidelines for Safety Inspection of Dams by the Department of the Army, Office of the Chiefs of Engineers. This determination is contingent on the requirements that static stability conditions are satisfactory and conventional safety margins exist.

6.3

Evaluation: The results of a previous stability analysis were not available for comparison as part of this evaluation of the Lake Devolia Dam. Sections of the downstream embankment of the dam are slightly steeper than the grade recommended by the Bureau of Reclamation guidelines. The upstream embankment appears to be overly steep due to the erosion that has gone unchecked above the water line. However, the crest is

NAME OF DAM: LAKE DEVOLIA DAM

significantly wider than that recommended by the guidelines.

Extensive repairs for damage from erosion on the upstream and downstream embankments and along the right downstream toe of the dam must be completed. The seepage area along the toe of the dam should be monitored at regular intervals and after periods of heavy inflow to the impoundment to detect possible flow increases or turbidity which may indicate a potential for piping of dam materials. If these conditions are observed, a qualified engineering firm should be retained to perform a stability check of the dam.

The principal spillways are inadequate to pass the SDF (as described in Section 5 of this report). Overtopping flows are relatively shallow, last for 1.2 hours and the velocity is less than 6.0 feet per second (f.p.s.), the effective eroding velocity for a vegetated earth embankment. However, the depth, duration and rate of overtopping flows are considered to be potentially detrimental to the stability of the embankment considering the present eroded and sparsely vegetated condition.

NAME OF DAM: LAKE DEVOLIA DAM

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment: No engineering data were available for use in preparing this report. Deficiencies discovered during the field inspection and office analyses will require further investigation and remedial treatment. The dam and appurtenant structures are generally in poor condition. Maintenance of the dam is considered inadequate.

Using the Corps of Engineers' screening criteria for initial review of spillway adequacy, the 1/2 PMF was selected as the SDF for the "small" size - "significant" hazard classification of Lake Devolia Dam. It has been determined that the SDF would overtop the dam by a maximum depth of 1.0 feet with an average critical velocity of 4.6 f.p.s. The total duration of overtopping would be 1.2 hours. The principal and emergency spillways are capable of passing up to 46 percent of the SDF or 23 percent of the PMF without overtopping the dam.

The spillways are adjudged as inadequate, but not seriously inadequate. The spillways have not been adjudged as seriously inadequate since there is not a high hazard of loss of life from large flows downstream of the dam. However, overtopping could be detrimental to the dam, considering the present eroded and sparsely vegetated condition of the downstream embankment.

The upstream and downstream faces, the junction of the right abutment with the downstream slope, and the toe of the dam all have erosion problems. The vegetative cover is poor. Debris and trash have accumulated in and around the principal spillways and discharge channels. A large seep area was observed at the left downstream toe of the embankment.

There is no warning system or emergency action plan currently in operation.

7.2 Recommended Remedial Measures: The seep area should be examined at regular intervals and after periods of heavy rains for any signs of increased flow or turbidity, which may indicate the potential for piping of embankment material. If increased flow from the seep area or turbidity are noted, a qualified geotechnical engineering firm should be retained to perform a stability check of the dam.

NAME OF DAM: LAKE DEVOLIA DAM

A warning system and emergency action plan should be developed and put into operation as soon as possible. The emergency action plan should list steps to be taken to help prevent failure of the dam in an emergency.

The following measures should be undertaken as part of a regularly scheduled inspection and maintenance program:

- 1) The left half of the downstream slope should be filled to a minimum slope of 2.5H:1V, compacted, graded, and seeded. A rock toe drain with proper filter should be constructed initially.
- 2) Fill, regrade, and recompact all areas of erosion on the embankment and establish a good grass cover over the entire dam.
- 3) Riprap should be installed upstream and downstream of the roadway that passes through the natural left and right emergency spillway areas to prevent erosion to the left and right abutments of the dam.
- 4) Place riprap on the upstream embankment to minimize erosion due to wave action.
- 5) Clear the debris from the 24-inch principal spillway inlet, discharge area, and downstream channel.
- 6) Repair and riprap the eroded outlet area for the 24-inch principal spillway. Also, riprap around the outlet of the 36-inch spillway.
- 7) Fill in, compact and reseed the existing discharge channel for the 24-inch principal spillway and construct a new riprapped discharge channel away from the toe of the downstream embankment.
- 8) Install trash racks or screens at the inlets to the 24-inch and 36-inch principal spillways to prevent obstruction of flow.
- 9) Anchor the half-sections of 54-inch C.M.P. to the embankment to prevent slippage.
- 10) Extend half-sections of pipe in the discharge channel for the 36-inch principal spillway beyond the toe of the embankment and tie in with the new 24-inch principal spillway discharge channel.

NAME OF DAM: LAKE DEVOLIA DAM

- 11) Install a staff gage to monitor reservoir levels above normal pool.
- 12) The pine trees seeded onto the embankment should be removed and the embankment mowed regularly.

NAME OF DAM: LAKE DEVOLIA DAM

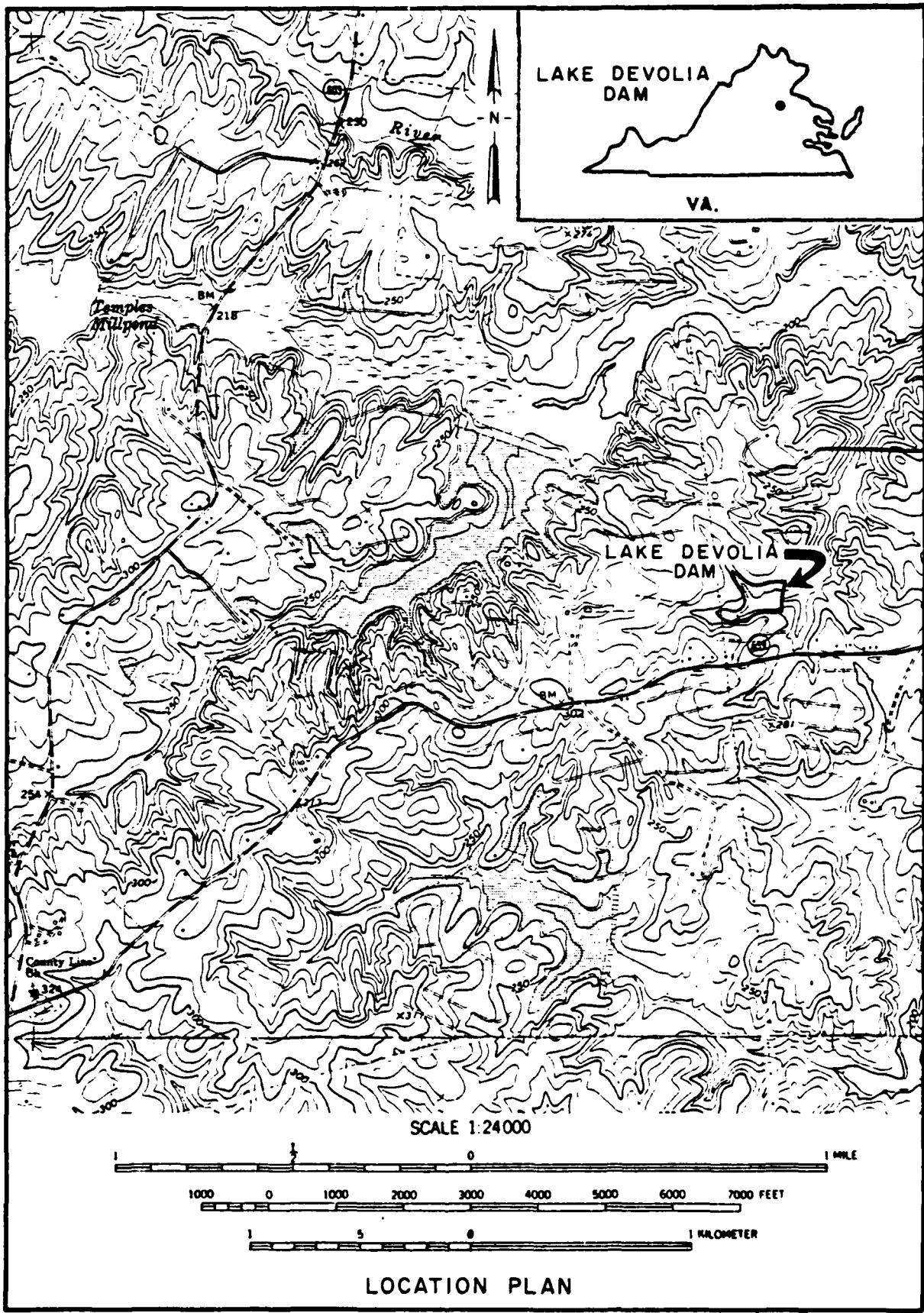
APPENDIX I

PLATES

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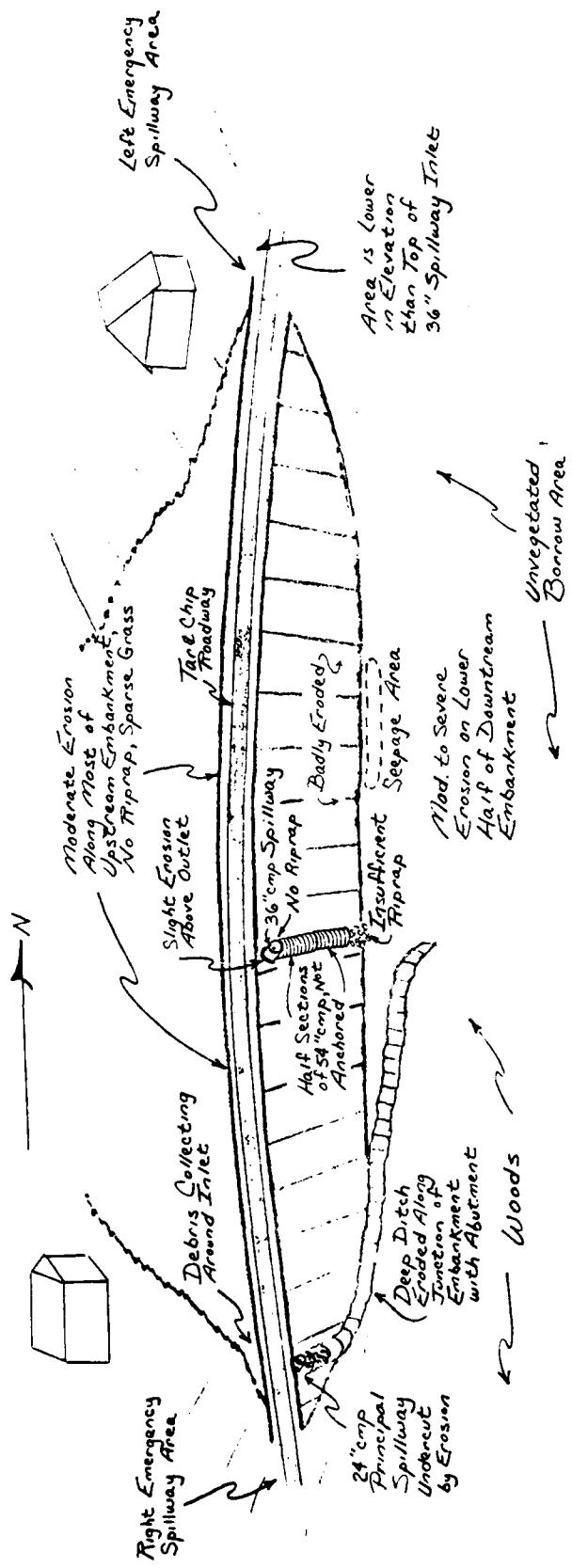
- Location Plan
- Plate 1: Field Sketch
- Plate 2: Top of Dam Profile
- Plate 3: Typical Cross-Section

NAME OF DAM: LAKE DEVOLIA DAM



Upstream Slope 2.0 - 2.5 H:IV
 Downstream Slope 2.2 - 2.6 H:IV
 Crest Width 28 feet minimum
 Height of Dam 20.6 feet

- Not to Scale -



FIELD SKETCH
LAKE DEVOLIA DAM, VIRGINIA

Michael Baker, Jr., Inc.
 28 October 1980

PLATE 1

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Top of Dam Profile Looking Downstream

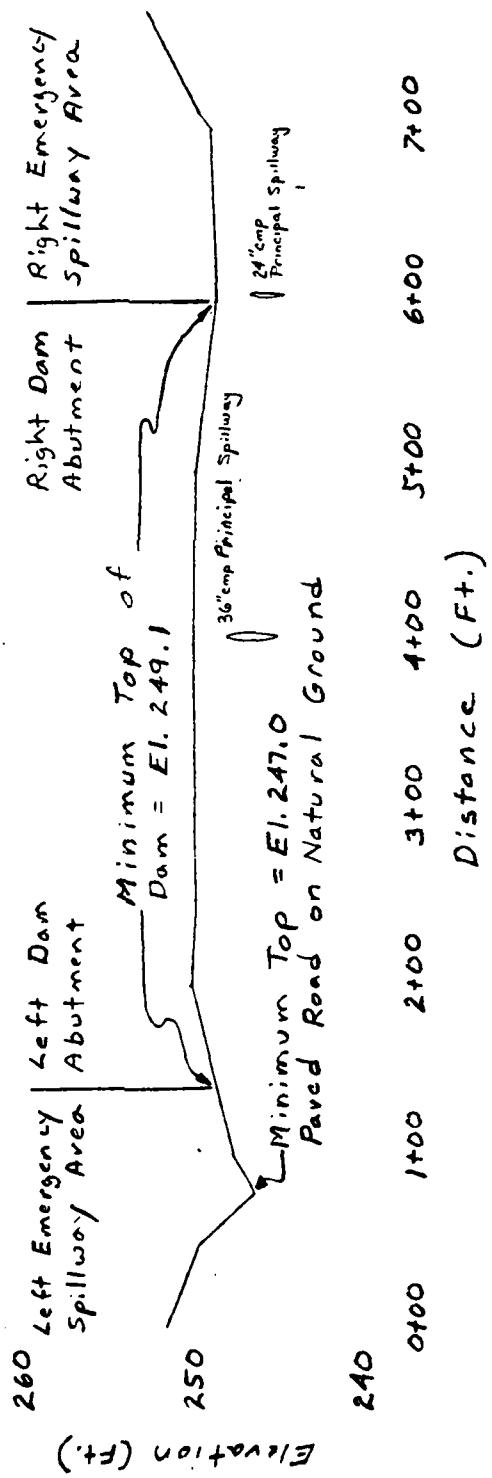


PLATE 2

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Cross Section at Sta. 2+50

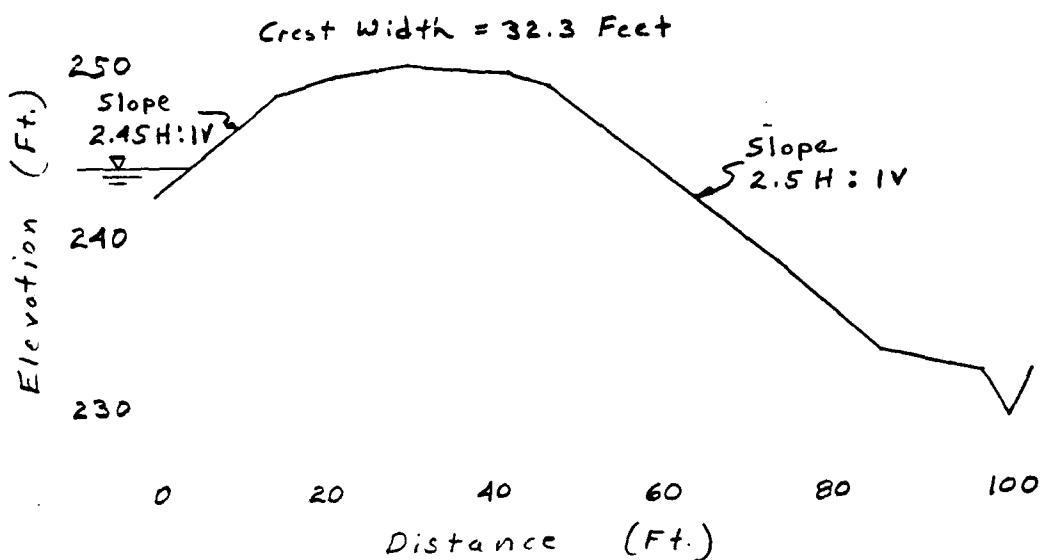
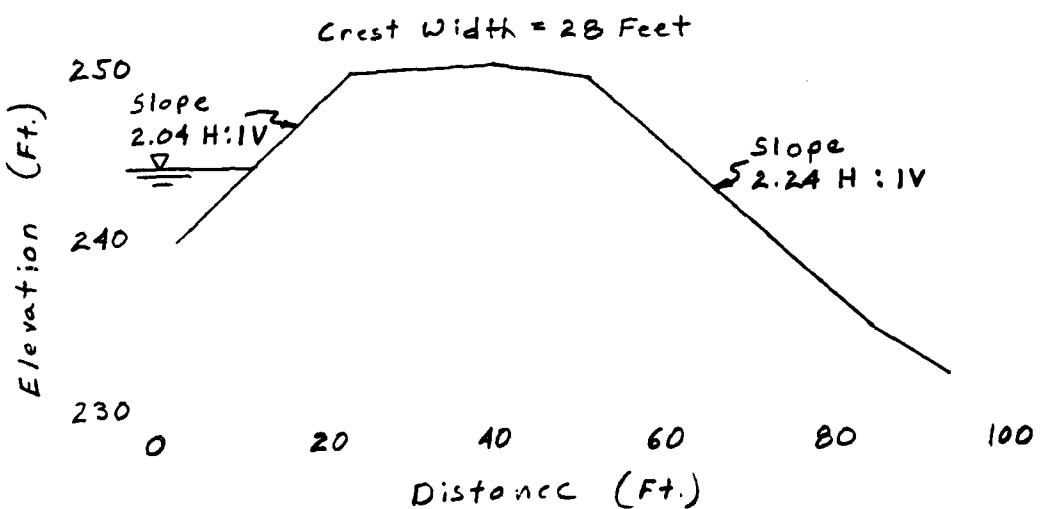


PLATE 3

Cross Section at Sta. 4+50



APPENDIX II
PHOTOGRAPHS

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- Photo 1: 24-inch Spillway Inlet
- Photo 2: Trash in 24-inch Spillway Outlet
- Photo 3: 36-inch Spillway Inlet, Steel Mesh Trash Screen
- Photo 4: 36-inch Spillway Outlet, Half-sections CMP Extending Down Embankment
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- Photo 6: Erosion of Downstream Embankment, Seepage Area Along Toe of Dam
- Photo 7: Eroded Ditch Along Right Toe from 24-inch Spillway Discharges
- Photo 8: Erosion and Sparse Vegetation on Upstream Embankment

Note: Photographs taken on 28 October 1980.

NAME OF DAM: LAKE DEVOLIA DAM

LAKE DEVOLIA DAM



PHOTO 1. 24-inch Spillway Inlet (Note: No Trash Screen)



PHOTO 2. Trash in 24-inch Spillway Outlet

LAKE DEVOLIA DAM

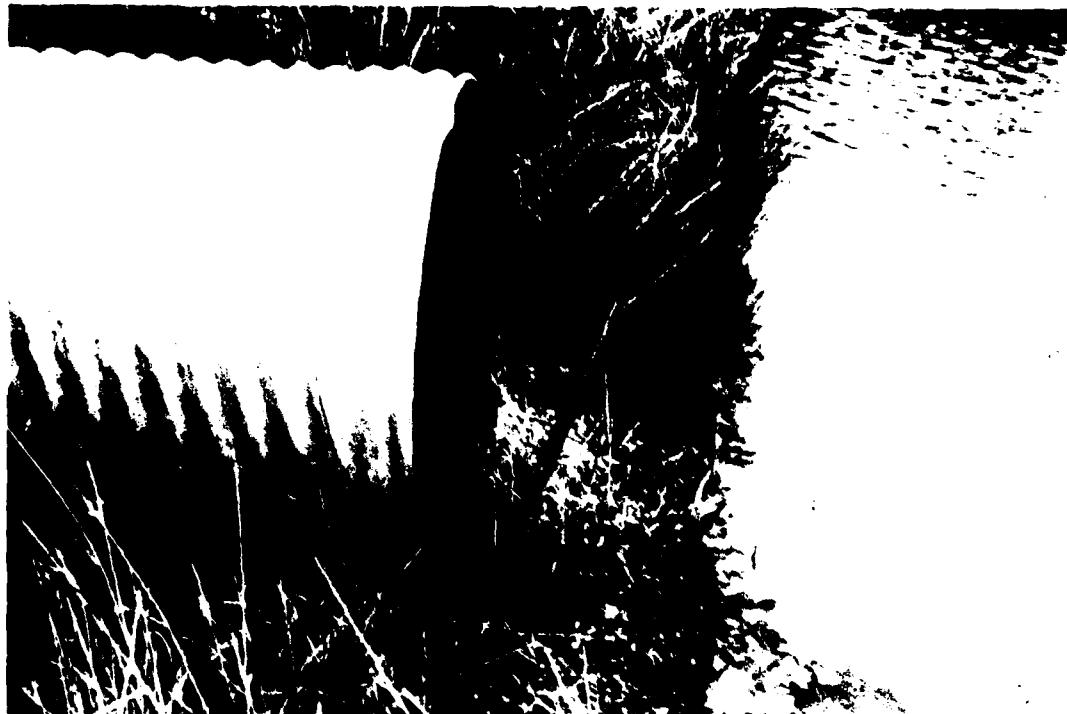


PHOTO 3. 36-Inch Spillway Inlet, Steel Mesh Trash Screen



**PHOTO 4. 36-Inch Spillway Outlet, Half Sections CMP Extending
Down Embankment**

LAKE DEVOLIA DAM



PHOTO 5. Downstream Embankment Overview



PHOTO 6. Erosion of Downstream Embankment, Seepage Area Along Toe of Dam

LAKE DEVOLIA DAM



PHOTO 7. Eroded Ditch from 24-inch Spillway Discharges, Along Right Downstream Toe of Dam



PHOTO 8. Erosion and Sparse Vegetation on Upstream Embankment

APPENDIX III
VISUAL INSPECTION CHECK LIST

Check List
Visual Inspection
Phase 1

Name of Dam Lake Devolia Dam County Caroline State Virginia Coordinates Lat. 3801.1
Long. 7732.7

Date of Inspection 28 October 1980 Weather Overcast, inter. rain Temperature 45-55° F.

Pool Elevation at Time of Inspection 244.5 ft. T.B.M.* Streambed at Time of Inspection 229.8 ft. T.B.M.

*Elevations were referenced to a Temporary Bench Mark (T.B.M.) located on the top center of the principal spillway, 24 in. C.M.P., at the inlet. The assumed elevation is 247.0 ft.

Inspection Personnel:

Michael Baker, Jr., Inc.:

David J. Greenwood
Larry A. Diday
David W. Hupe

Virginia State Water Control Board:

Ed Constantine

Owner's Representatives:

Mr. Robert Oberbrockling -
Manager, Lake Land'or
Property Owners' Association.
Meeting before inspection.

David W. Hupe _____ Recorder

Name of Dam LAKE DEVOLIA DAM

EMBANKMENT

<u>VISUAL EXAMINATION OF</u>	<u>OBSERVATIONS</u>	<u>REMARKS OR RECOMMENDATIONS</u>
<u>SURFACE CRACKS</u>	None observed. The ground surface at the embankment and abutment was damp.	
<u>UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE</u>	None observed. The toe area of the right downstream embankment has been badly eroded by discharges from the 24 in. spillway.	
<u>SLoughing OR Erosion OF EMBANKMENT AND ABUTMENT SLOPES</u> III-2	The downstream embankment (particularly the lower half) is moderately to severely eroded. The left half of the downstream embankment is the more severely eroded and is too steep (about 2.2H:1V). Pine trees up to 6 ft. high have seeded onto the embankment. The upstream embankment has been moderately eroded from precipitation and wave action. The vegetative cover is generally poor. There is no riprap on the upstream embankment.	The small trees should be removed and a good vegetative cover established over the entire downstream embankment. The embankment should be mowed regularly. Riprap should be placed on the upstream embankment to minimize erosion. Eroded areas should be repaired, regraded and the entire dam reseeded. The left half of the downstream embankment with the steep slope should be filled to a slope of 2.5H:1V, compacted, graded and seeded. A rock toe drain should be installed.

EMBANKMENT

Name of Dam LAKE DEVOLIA DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	The maximum elevation of the crest (250.6 ft. T.B.M.) varies with the minimum elevation, at the left and right abutments, (249.1 ft. T.B.M.) of the embankment by about 1.5 ft. No significant horizontal misalignment was observed.	Riprap should be added on the upstream embankment to minimize erosion.
RIPRAP FAILURES	There is no riprap on the embankment.	
EMBANKMENT MATERIALS	The embankment was constructed from red to brown sandy silt (local borrow from below and above the dam) containing a little fine to medium gravel.	

EMBANKMENT

Name of Dam LAKE DEVOLIA DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	The junctions of the embankment with the abutments are not eroded except that the junction of the downstream embankment with the right abutment has been eroded by discharge from the 24 in. spillway.	The eroded channel should be filled and revegetated. A riprapped channel should be constructed to convey future discharges east and away from the toe of the dam.
ANY NOTICEABLE SEEPAGE	A 50 ft. long seepage area occurs along the left downstream toe of the dam. Measureable flow was not observed. The seepage appears to occur from light grey, slightly silty sand that was found to be exposed in the lower embankment. Piping does not appear to be occurring. The light grey soil appears to be in place soil.	The seep should be examined at regular intervals and after periods of heavy rain for turbidity and/or increase in flow, which may indicate the potential for piping of embankment material. If turbidity or increased flows are noted, a qualified geotechnical engineering firm should be retained to perform a stability check of the dam.
STAFF GAGE AND RECORDER	None observed	A staff gage should be installed to monitor reservoir levels above normal pool.
DRAINS	No toe drains were observed.	

Name of Dam: LAKE DEVOLIA DAM

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	N/A	
INTAKE STRUCTURE	The 24 in. C.M.P. principal spillway inlet is not protected with a trash rack or riprap. Trash (logs, etc.) are present near and in the inlet. The 36 in. C.M.P. principal spillway inlet is partially protected by a section of steel screen held loosely against the lower half of the opening by a steel stake. The screen is not clogged. The inlet area is not protected by riprap.	Full size trash racks should be installed at the inlets to both the 24 in. and the 36 in. spillway pipes.
OUTLET STRUCTURE	The outlet for the 24 in. principal spillway was riprapped, but the riprap has been washed away. The outlet has been undercut about 2 ft. Debris (logs) is present in the 24 in. principal spillway outlet. The outlet area of the 36 in. principal spillway (the embankment) is protected by un-anchored half-sections of 54 in. C.M.P. The half-sections do not extend beyond the toe of the dam. The half-sections of pipe empty onto riprap just above the toe of the dam. The outlet area of the 36 in. principal spillway is eroded near the top of the embankment.	The undercut area of the 24 in. spillway should be repaired and proper size riprap protection installed. The half-sections of C.M.P. should be anchored to prevent slippage and extended to protect the toe of the dam. The immediate outlet area of the 36 in. spillway should be riprapped.

Name of Dam: LAKE DEVOLIA DAM

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
OUTLET CHANNEL	The outlet channel for the 24 in. principal spillway extends along the right downstream abutment and toe of the dam toward the 36 in. principal spillway outlet channel. The toe of the dam and right downstream abutment have been severely eroded by discharges from the 24 in. principal spillway forming a ditch approximately 4 ft. deep.	The eroded channel should be filled and revegetated. A riprapped channel should be constructed to convey future discharge east and away from the toe of the dam.
EMERGENCY GATE	There is no emergency gate.	

Name of Dam: LAKE DEVOLIA DAM

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	N/A	Riprap should be installed over the dam and abutment areas to minimize erosion if the natural overflow emergency spillways are activated.
APPROACH CHANNEL	The reservoir is the approach channel for the left and right emergency spillway areas. On both sides of the embankment and adjacent to the abutments are natural overflow areas. The left overflow area being at elev. 247.0 ft. T.B.M. is lower than the right overflow area, which is at elev. 249.1 ft. T.B.M., the same as the minimum top of dam. There is no riprap on the reservoir side of either the left or right emergency spillway areas.	Riprap should be placed on the downstream side of the roadway in the natural discharge areas to prevent erosion to the abutments.
DISCHARGE CHANNEL	The discharge channel for the left and right emergency spillway areas is a two lane tar and ship roadway. The channel is unobstructed. Water then passes over the natural discharge areas adjacent to the left and right abutments of the embankment.	Riprap should be placed on the downstream side of the roadway in the natural discharge areas to prevent erosion to the abutments.
BRIDGE AND PIERS	N/A	

INSTRUMENTATION

Name of Dam: LAKE DEVOLIA DAM

	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
VISUAL EXAMINATION		
MONUMENTATION/SURVEYS	None present	
OBSERVATION WELLS	None present	
WEIRS	None present	
PIEZOMETERS	None present	
OTHER		

RESERVOIR

Name of Dam: LAKE DEVOLIA DAM

<u>VISUAL EXAMINATION OF</u>	<u>OBSERVATIONS</u>	<u>REMARKS OR RECOMMENDATIONS</u>
SLOPES	The slopes around the reservoir are very gentle and wooded with scattered homes. The banks of the reservoir are well vegetated with medium to tall grasses and some trees. No significant erosion of the reservoir banks was observed.	
SEDIMENTATION	No significant sedimentation was observed. Soundings taken during the inspection indicate the water depth to be about 11 ft. below the pool level at the time of inspection. Soundings were taken approximately 100 ft. offshore from the embankment.	

Name of Dam: LAKE DEVOLIA DAM

DOWNSTREAM CHANNEL

<u>VISUAL EXAMINATION OF</u>	<u>OBSERVATIONS</u>	<u>REMARKS OR RECOMMENDATIONS</u>
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	The downstream channel is a wide, unobstructed natural channel. Flows through the channel enter into an unnamed tributary to South River and pass under VA Route 622. No significant debris or obstructions were observed.	
SLOPES	The downstream channel slope is fairly flat, less than one percent on the average. The slopes of the area bordering the downstream channel are moderate and wooded.	
APPROXIMATE NO. OF HOMES AND POPULATION	Homes along the South River just upstream of U.S. Route 1, the VA Route 622 and the two lane tar and chip road on the crest of the dam could suffer economic damage by large flows from the dam.	

APPENDIX IV
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GENERAL REFERENCES

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